Division of Agricultural Sciences
UNIVERSITY OF CALIFORNIA

PRUNING CITRUS TREES

C. D. McCARTY
S. B. BOSWELL
R. M. BURNS
R. G. PLATT
K. W. OPITZ
L. N. LEWIS

CALIFORNIA AGRICULTURAL
Experiment Station
Extension Service

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This circular tells the citrus grower—

- how trees react physiologically to pruning
- what conditions are necessary for pruning
- about pruning in the nursery, in the young orchard, and in the mature orchard.
- about methods of pruning different varieties of citrus
- how to prune after injury
- how and when to prune by hand or mechanically
- how diseases can be spread by pruning and how to care for pruning wounds
- about pruning equipment

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THE AUTHORS:

C. D. McCarty is Horticultural Technologist, Agricultural Extension Service, Riverside; S. B. Boswell is Specialist, Department of Plant Science, Riverside; R. M. Burns is Farm Advisor, Ventura County; R. G. Platt is Subtropical Horticulturist, Agricultural Extension Service, Riverside; K. W. Opitz is Subtropical Horticulturist, Agricultural Extension Service, Kearney Horticultural Field Station, Parlier; and L. N. Lewis is Professor of Plant Physiology, Riverside.

Pruning Citrus Trees

Foliage cut from healthy, mature citrus trees reduces yield in proportion to the amount of foliage removed. Pruning young, nonbearing trees delays fruiting. Pruning, therefore, should be limited to that required for future tree development and for essential cultural operations—and should be adjusted to the requirements of the individual tree.

Location of food storage differs between deciduous fruit trees and evergreen citrus. During the summer the majority of excess food manufactured by deciduous trees is stored in the root system. Pruning deciduous trees while they are dormant does not appreciably reduce the supply of stored food, and it remains available for the spring growth flush.

In citrus trees, on the other hand, carbohydrates are stored in the leaves, twigs, and branches; only a minor amount goes to the root system. The maximum amount of stored food is reached in late February or early March just before spring growth activity. Thus, the foliage of a citrus tree serves as an important food storage area, and pruning, which removes this foliage, causes the tree to produce a vegetative growth flush at the expense of fruit production.

Hormones or growth regulators which occur in the citrus tree, may affect fruit set considerably according to recent experimental work. Just how pruning affects the action of these hormones is not completely understood. Citrus trees deficient in both carbohydrates and nitrogen grow and fruit poorly. If the tree is low in carbohydrates, and if nitrogen is available, vegetative growth is produced. When stored carbohydrates and nitrogen are at optimum levels, both fruiting and vegetative growth are more likely to occur.

Pruning in the nursery[1]

The first pruning often occurs when the young seedlings are removed from the seedbed. In most cases it is necessary to trim the roots. Cutting back the top may be needed to bring it into balance with the reduced root system, since the roots must supply the leaves with sufficient water to prevent permanent wilting.

Following pruning, the seedlings are transplanted to the nursery row. After growth resumes, suckers which sprout from the lower portion of the trunk to a height where budding is to take place should be removed (preferably by rubbing with a gloved hand). Sucker initiation may be prevented by wrapping the seedling trunk with aluminum foil.

Rough lemon, macrophylla, citrange and large-flowered strains of trifoliate orange seedlings grow upright with a single trunk and usually require little pruning. Sweet orange, grapefruit, tangelo, mandarin seedlings, and small-flowered trifoliates tend to branch lower and need more pruning.

A few weeks before budding, the rootstock seedlings may be pruned to a single bare trunk 12 to 15 inches high, so the stock will be free of growth for bud insertion. Pruning causes a temporary tightening of the bark and should be completed at least three

[1] For detailed information on growing nursery citrus, see Extension Circular 546, "Propagation of Citrus," by K. W. Opitz, R. G. Platt, and E. F. Frolich.

Fig. 1. Budded seedling. Stock has been pruned above point of budding. Top is bent over to favor growth of scion.

weeks before budding, so that the cambium will again be in an active state of growth and slip freely. Seedlings also can be pruned when budded.

Topping, lopping or bending is usually necessary to check the vegetative growth of the rootstock, which forces growth of the bud after it unites with the stock. In topping, the trunk is cut off a few inches above the bud. When trees are lopped, the seedling trunk is partly cut through about three inches above, and on the same side as the bud. The top is not removed; instead it is laid over on the ground. This allows the leaves of the rootstock seedling to continue to manufacture and supply food to the roots and developing bud shoot. In bending, the seedling top is bent over by flexing without cutting (fig. 1). The nurse top is not removed until the shoot from the bud has grown to a sufficient height. In some cases the rootstock top is allowed to remain until the following spring.

After the bud shoot grows to a height of 2 feet or more, the rootstock stub is cut off evenly and neatly on a slant just above the bud union. The cut should be painted with a protective covering, such as an asphalt-water emulsion paint. This cut should not be made late in the season, since it makes the young tree more susceptible to cold injury.

Little pruning, except for sucker removal, is needed until trees are headed for field planting. Usual heading height is about 30 inches for all varieties of citrus. Satsuma mandarin is an exception; it is sometimes headed at a slightly lower height because of its slower growth habit.

Nursery trees topped to form a head should be pruned again just before digging. Three to five well-spaced branches are left around the top of the tree and cut back to lengths of 5 to 8 inches. This pruning brings the top into balance with the root system, which is reduced during the balling operation. If the trees are dug bare-root, a larger root system is left. However, the balance between top and root may be even more critical due to possible drying of roots.

A second method is to grow the trees as "whips" or "canes," which are topped as a single stem at the time of digging. The whip system is often used with younger trees, which are field-planted one year after budding. Older trees may also be cut back to a single trunk when field-planted.

Pruning the young orchard

Most citrus trees need no pruning for two or three years after transplanting to the field—except to remove shoots if they sprout from the trunk below the head of the tree. Wraps placed around the trunks to prevent sunburn also provide enough shade

Fig. 2. Natural growth sequence. Upright growing limbs will bend from their own weight. Further upward growth will be from new shoots along the upper sides of these limbs and from the center of the tree. The skirt is formed by laterals which droop to the ground. (Lewis and McCarty.)

to reduce or prevent most trunk sprouts.

Occasionally, a small, weak tree produces a vigorous sucker, which dominates the tree from a point above the bud union on the main trunk. Suckers may also arise from the rootstock. These suckers must be removed before they gain dominance.

Selection of scaffold branches

The intended life of an orchard is a major consideration in pruning. Urban development, for instance, might dictate an orchard's life to be no more than 10 to 15 years. Pruning, then, is of little value. On the other hand, if the orchard is a long-term operation, careful and limited pruning to establish good tree form is worth the sacrifice of a certain amount of fruit.

Selection of permanent scaffold branches during the first two or three years of the tree's life usually fails. When trees are headed for field planting, only buds close to the point of heading sprout. These are closely spaced and grow upward until they bend under their own weight to form laterals. New buds sprout from the center of the tree and from along the upperside of these bent branches, which droop even further to form the tree's skirt. As the new branches grow upward, they also bend, and the process is repeated. Under these conditions, dominance jumps from one branch to another, and what may seem a good choice for a main branch one year may not be the dominant branch the following year. Pruning at this stage often hinders, rather than helps, the normal growth pattern. Figure 2 shows a natural growth sequence at this stage.

As the tree grows older and increases in size, the center fills with closely spaced and crossing branches. When the tree is 3 or 4 years old, depending on size and growth rate, light, selective thinning may be done (see fig. 3) to remove branches which are too closely spaced or are crossed and entangled. This pruning should not be heavy; rather, it should just be sufficient to establish the scaffold framework.

Small irregularities in the canopies of young trees should be ignored (fig. 4). Left alone, citrus trees normally develop a relatively even spherical shape as they mature.

Fig. 3. Light selective pruning should be done to remove crossing branches and those which are too closely spaced.

Fig. 4. Lopsided tree caused by a dominant fast-growing limb. Such cases are the exception. While pruning may be used to force the tree into a more normal growth habit the condition will usually correct itself if left unpruned, and the tree will assume a normal shape. (Lewis and McCarty.)

Pruning during the next 5 or 6 years should be limited to the removal of occasional branches that interfere with the growth of a sturdy framework of scaffold limbs.

Undesirable shoots, which sprout following pruning, should be removed when they are a few inches long and are still tender enough to be removed with a gloved hand. Allowed to grow, they deplete the tree of food reserves and necessitate more severe pruning later.

When pruning, it is best to remove unwanted limbs at the point where they originate, or they should be cut back to a lateral. This reduces the sprouting of new buds in the area around the cut. Heading of a wanted limb may be done when needed to induce branching or to strengthen its growth, if it is weak or willowy.

Pruning cuts should be made as near the vertical plane as possible, since the nearer to horizontal the cut, the greater the sprouting of new buds.

Mandarins and lemons. Orange and grapefruit trees should be pruned alike during the early years of the orchard's life. However, some varieties of mandarins may require removal of weak branches and heading back to laterals of limbs to be kept in order to encourage vigorous shoot growth.

Lemon trees, because of their open, irregular growth habit, require some pruning but less than generally believed. Unpruned lemon trees fruit early and abundantly. However, lemon trees tend to produce long, spindly shoots which are mechanically weak and easily broken. It is often necessary to remove some of these by thinning or to shorten others back to laterals to strengthen them. Lemon trees also send out strong laterals through the center of the tree. Without pruning, the interior of the tree fills with crossing limbs.

A good framework of scaffold branches helps prevent limb breakage. To neglect early selective pruning of lemon trees will necessitate heavy cutting later on, which causes a delay and reduction in yield.

Two types of pruning systems have been used for lemons: one, mainly a severe heading back of branches with some thinning where crowding of limbs occurs; two, mainly a thinning of branches with a light heading back to laterals where needed.

With the heading method, upright growing branches are cut back severely. New shoots which sprout near the tops of these cut branches are thinned and cut back in the same manner. Some inside wood is removed to prevent the tree from becoming too dense. This pruning produces a small, compact tree—as well as delayed fruiting and reduced yield.

Thinning, on the other hand, requires selection of three to five upright leaders to become the main scaffold branches. These leaders are maintained by light pruning. Competing shoots are removed while they are still small. A minimum of foliage is removed with just enough pruning to keep the trees relatively open. In order to discourage the bending of fruiting uprights, the terminals are pruned before fruit production becomes too heavy. If a main limb bends to the point where it becomes a lateral, it is replaced by a strong, nearby upright shoot.

No undercutting or removal of low branches is done until "shading out" begins to occur.

Young, vigorously growing lemon trees are susceptible to breakage by strong winds. Shortening tall growing uprights plus thinning of unneeded limbs helps to lessen this damage.

Pruning the mature tree

Bearing orange and grapefruit trees require little pruning. Most of the experimental work with citrus indicates that yield from healthy trees is reduced in proportion to the severity of pruning. To facilitate certain management procedures, there are conditions where light pruning is advantageous. Light thinning in the top of the tree to promote the growth of inside fruitwood may be helpful. For better pest control and ease of harvesting, limiting tree height may have merit, but if excessive its advantages are easily outweighed by the loss of fruit-bearing foliage.

As the trees age, in uncrowded orchards, the top branches are usually the first to decline in production and fruit quality. A light thinning of the top promotes the growth of new fruitwood, but such pruning should not open the tree to the point where sunburning of exposed branches occurs. If a limb is exposed to sunburn it should be protected by a coating of whitewash. When thinning the top of the tree, branches should not be cut

Fig. 5. Weak and dead wood is removed from inside the tree's skirt. This type of pruning, called undercutting, stimulates new growth and maintains the bearing efficiency of the skirt.

back as stubs. Instead, the limb should be cut back to another branch or lateral. Most deadwood may be removed, but it is seldom economically feasible to remove every twig. Weak, non-productive wood should be removed from the center of the tree, but vigorous shoots should, where possible, be retained and bent over to fill thinly foliated areas with fruitwood.

The skirt of the tree bears a large portion of the fruit, and pruning should be slight until the productive wood begins to decline. Non-productive skirt branches should be removed by cutting from beneath, leaving the upper and newer foliage to replace that taken out. Known as undercutting, this helps insure the bearing efficiency of the skirt (fig. 5).

As the trees grow larger, it may be necessary to prune to restrict each tree to a given area as limited by spacing. This is particularly true in close spaced orchards. Pruning to hold trees to a given size requires judicious hand pruning and results in some loss in yield. Where trees are extremely close, a better solution is to remove alternate trees. This should be done before crowding reaches the point where most of the skirt fruitwood is lost from shading.

The growth habit of mature lemon trees is more open and irregular than other varieties of citrus; unpruned,

Fig. 6. Pruning the mature lemon tree. Fast growing upright shoots are shortened back to laterals and the inside of the tree is thinned. Light frequent pruning is preferable to heavy pruning at longer intervals.

they usually produce abundantly. However, unpruned trees grow into a tangle of weak and interlaced branches. Such trees are difficult to harvest and efficient pest control is a problem. Crowding also makes other cultural operations more difficult. In addition, nonpruning hastens the development of sieve-tube necrosis in certain selections of lemon varieties. Dysfunction of sieve tubes in the phloem can be reduced, if not eliminated, by proper pruning.

A systematic pruning program, begun when lemon trees are small, should be continued into maturity. Light, frequent pruning is advisable. Periodic thinning of unwanted branches, and shortening of others to laterals, results in the development of a low-spreading tree from which the fruit is easy to harvest. (See fig. 6.)

Mechanical hedging (figs. 7a and 7b)

The development of mechanical hedging and topping machines has changed pruning methods. Hedging consists of cutting the side of the tree back vertically. If the trees are tightly grown together, hedging will open up the orchard, remove dead and weak wood, and in some cases allow the tree to grow a new skirt. In addition the grove is opened for the passage of equipment needed for grove maintenance. A more efficient coverage of insecticidal sprays may result, and harvesting of fruit may be made easier.

In recent years, closer tree spacing has become the accepted planting

Fig. 7a. Trees in foreground have been hedged. Compare with unhedged trees in background. A light hedging before trees begin to crowd is more practical than heavy cutting after the trees have grown together. (After Lewis and McCarty.)

Fig. 7b. Tilting the cutting arm toward the center of the row gives a "Christmas tree" effect and allows more light to reach the lower portion of the trees.

practice in many California orchards. As these trees reach maturity, pruning becomes necessary to prevent the shading out of lower parts of the tree. In some cases the arm holding the cutting blades is tilted slightly toward the top of the tree. Cutting on a slant allows more light to reach the lower foliage. Mechanical hedgers offer a quick and economical way to open close-planted groves. The principal disadvantage is that mechanical hedging is nonselective, removing both bad and good wood.

Hedging leaves numerous exposed stubs along the side of the tree from which new buds sprout. This produces a wall of new foliage. Depending upon the amount of wood and foliage removed, yields are usually reduced the year following hedging. Light hedging reduces yield less than heavy hedging, and in some cases a light hedging which opens the orchard to better illumination and prevents the shading of lower fruitwood results in increased yields over similar non-hedged orchards.

Mechanical topping (fig. 8)

Convenient picking height and economics usually determine the need for mechanical topping in lemon orchards.

Mechanical toppers are also used to remove the tops of declining orange and grapefruit trees to allow light into the trees to stimulate the growth of new fruitwood. Topping is a heading-back type of pruning, and numerous buds sprout from around the cut stubs. This growth, often referred to as "cabbage heads" must eventually be thinned by selective hand pruning, since it becomes so dense that it shades out the interior of the tree. Many growers follow a program of alternating mechanical topping with hand pruning. Other growers machine top just before hand pruning so that pruners have less brush to handle. More uniform tree height is also maintained by this method.

Light mechanical pruning of citrus usually does not decrease yields as persistently as hand pruning. This may be due to a tendency for some hand

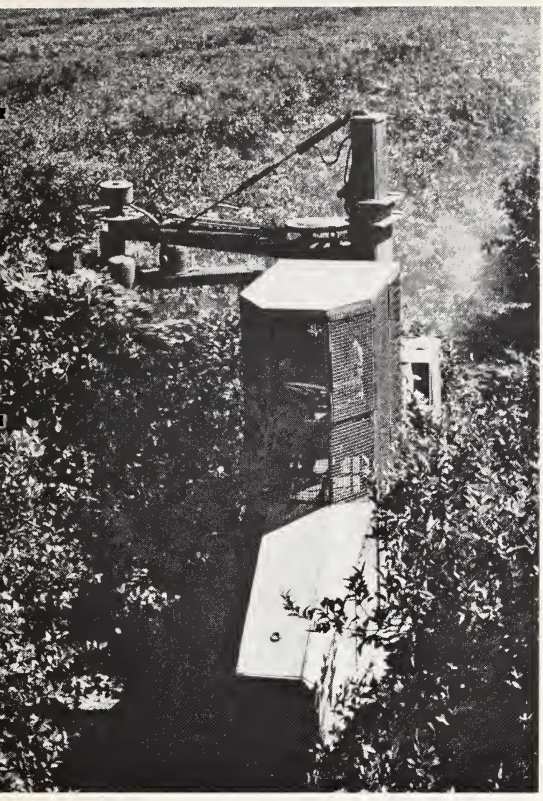

Fig. 8. Mechanical topper. Circular saws mounted on rotating arms. Combined action of rotating saws and arms helps throw the cut branches out of the tree into the row. (Photo courtesy Kimball Toppers.)

pruners to take out too much productive fruitwood.

Following severe freezes it has been noted that fruit on mechanically topped and hedged trees is more severely injured than fruit on unpruned check trees. Fruit on recently pruned trees lacks the protective cover of foliage and is exposed to greater radiation which lowers fruit temperature below that of unexposed fruit.

Pruning injured trees

Trees injured by frost, severe windburn, or rodents, will require special pruning. Periodic freezes of moderate to severe intensity occasionally occur in all of the major citrus-growing areas of the state. If the damage is light, and only foliage and small twigs are injured, pruning is not required. When larger limbs are killed by a severe freeze, pruning is necessary.

Freeze damage ordinarily becomes visible within a few days on foliage and young growth; it is impossible to determine the full extent of injury immediately after a freeze on older parts of the tree. Dieback may continue during the entire season when severe freezes occur. On the other hand, wood which at first appears to be so severely injured that it should be removed will recover. Because of this, pruning should not be done for at least six months to a year after damage has occurred. Enough time should be allowed for new growth to take place, and for dieback to cease so that the extent of damage is clearly defined. If freeze-injured trees are not pruned until regrowth is well under way, recovery will be more rapid than if the trees are pruned immediately following injury.

When pruning is done, injured limbs should be cut back below all serious bark damage to a point where vigorous new sprouts are growing. It may be advisable to aid the formation of new framework branches by a further light pruning, if and when it is needed.

In cases of extremely severe damage, where the entire top of the tree is killed and injury extends to the trunk, a new head must be developed. The old trunk and top should be removed as soon as the extent of damage is determined. Under these conditions, the new tree which is formed may have a multiple trunk system. Experience shows this is not objectionable. Following the freeze, and until the new head is fairly well formed, all sprouts should be allowed to grow in order to bring the top and root system back into balance. Once this occurs, exces-

sive growth should be pruned leaving several shoots to form the new scaffold framework of the tree.

Where the top of a young tree is killed, it is best to rebuild the top by favoring the growth of one strong shoot. The shoot chosen to form the new top should be forced by pinching back other sprouts as they appear.

Hot, dry winds will occasionally injure trees. Many of the defoliated limbs will recover; however, recovery is usually slower than from frost injury. Branches which do not recover should be pruned from the tree carefully so that a minimum of healthy foliage is lost.

Breakage from strong winds sometimes occurs. Young, vigorously growing lemons are most susceptible. Where a crop is on the tree, and the limb is still attached enough to allow the fruit to mature, pruning can be put off until after harvest. A follow-up pruning will be needed to thin excessive regrowth.

Gopher injury usually confronts every grower. Normally gophered trees are healthy, and will recover unless badly girdled. When root damage is so extensive that remaining roots cannot supply water for the top, the top-root balance should be restored by pruning. If the tree is completely girdled, it can often be saved by immediate inarching followed by severe pruning.

Time of pruning

Since time of pruning is not highly critical with citrus, trees are often pruned when other cultural operations are at a low ebb, and it is convenient for the grower. Experiments have shown that the best results, from the physiological standpoint of the tree, can be expected if pruning takes place early in the spring after danger of frost has passed and before the start of a new growth cycle. Rate of foliage regeneration is most rapid on spring-pruned trees and least rapid when trees are pruned late in the fall. Also, fall pruning stimulates a late flush which is tender and more susceptible to frost injury during the following winter.

Time of pruning may be restricted by the presence of mature fruit on the trees. Little problem is presented with navel oranges and winter grapefruit, when the crop is harvested before spring. With Valencia orange and summer grapefruit trees, both young and mature fruit are on the tree at the same time, and late summer pruning after harvest may be preferred when fruit is at its scarcest. In some cases, it may be desirable to take advantage of the alternate bearing tendency of some species of citrus and prune during the light crop year.

In coastal areas, lemons are usually pruned after the last main summer harvest so that fewer nearly mature fruit are lost.

Rejuvenation pruning

One of the major problems in California's orange production in recent years has been a reduced tree vigor, especially in older groves, resulting in small fruit and low yields. Loss of vigor has usually been accompanied by a dieback of twigs and small branches from which no primary pathological organisms can be isolated.

This decline may be caused by increasing age of the tree, low rainfall, faulty irrigation, salt accumulation in the soil, virus and pest problems and air pollution—either separately or in various combinations.

Rejuvenation pruning forces the tree to produce new fruitwood and ranges from a moderate thinning of the canopy to complete skeletonization of the tree (fig. 9). This latter removes all foliage and wood smaller than an

Fig. 9. Skeletonized grapefruit tree. All foliage and branches smaller than approximately 1 inch in diameter have been removed. Cut brush is placed back in tree to help prevent sunburn.

inch in diameter, leaving only the main scaffold and adjoining branches. When older and weaker parts of the tree are removed, new buds sprout, and new fruitwood is formed. However, unless the cause of the decline has been corrected, the effects of pruning are temporary and the trees soon decline again.

A well-planned program of irrigation, fertilization, and pest control, as well as pruning, is needed to bring a rundown orchard back into production.

Heavy pruning of lemon trees affected with such diseases as shell bark or sieve-tube necrosis can keep these trees productive for many years.

Care of pruning wounds

In the dry climate of California, decay-producing organisms rarely enter through pruning wounds. Also, mechanical pruning, which leaves numerous cut stubs, has made treatment impractical. Large wounds, however, can be encouraged to heal with a water-based asphalt emulsion. This material must not contain solvents which could penetrate and kill the cambium. Whitewash, bordeaux paste, lead paints, or varnishes and shellacs are not satisfactory for treating cut surfaces, since they soon dry, crack, and lose their protective qualities. Where gummosis is a problem, fresh cuts may be painted with avenarius carbolineum.

Bark on limbs grown in the shade is susceptible to sunburn, and a few hours' exposure may cause injury. In some cases, especially when trees are topped, the exposed portion of limbs should be treated with whitewash. Treatment of branches other than those exposed to the sun is unnecessary and may even be detrimental, since whitewash provides an excellent habitat for the development of red spider. It may also delay sprouting of buds. If a few trees are to be treated, application can be done with a brush, but if large numbers are treated, a more practical method is to use a power sprayer.

Spread of disease by pruning

Exocortis can be transmitted from an infected to a non-infected tree by knives, pruning tools, and even by hands. It is more readily transmitted to lemon than to orange, grapefruit, or mandarin trees. When the rootstock is trifoliate orange, citrange, or Rangpur lime, mild to severe stunting of trees can occur. Trees on other rootstocks, even though infected, are tolerant and show little or no effect.

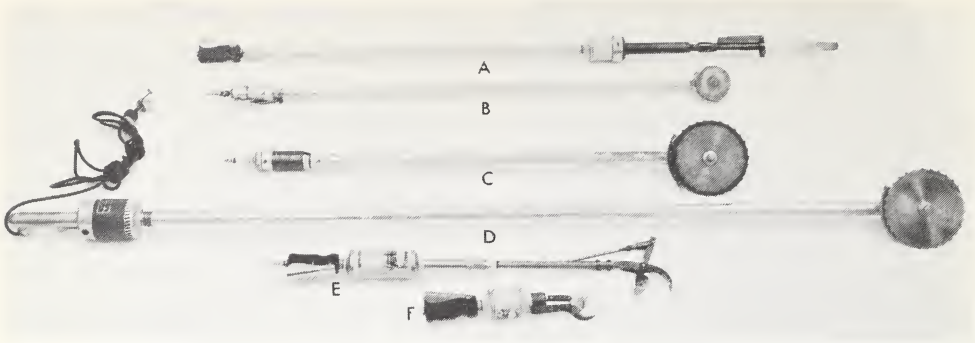

Fig. 10. Pneumatic and electric pruning equipment. Use of power tools is becoming increasingly popular.

In pruning orchards on exocortis-susceptible rootstocks, care should be taken to avoid cutting exocortis-infected trees before moving to non-infected trees. Tools should be disinfected by dipping in 1½ pints of household bleach diluted with water to make 1 gallon. To counteract the corrosive action of the disinfectant, pruning tools should be cleaned after use, in a mixture of 2 teaspoons of emulsifiable oil in one-quarter pint of vinegar diluted with water to a total volume of 1 pint. This mixture should be shaken vigorously just before use.

Since large mechanical equipment, such as hedgers and toppers, is impractical to disinfect, known infected trees should be cut last.

Ferment gum or Rio Grande gummosis is another disease which may be transmitted by pruning tools. It occurs in grapefruit and is characterized by an amber to reddish, often frothy, gum which is exuded profusely from cracks in the bark of trunks and limbs. Trees with this disease generally deteriorate and sometimes die.

To prevent spread of this disease, pruning tools should be disinfected with the bleach solution, as mentioned above, when moving from one tree to the next, particularly from a diseased tree to an apparently healthy tree. Also, pruning cuts greater than 1 inch in diameter should be treated with avenarius carbolineum.

Pruning equipment

For hand-pruning a good pair of long-handled loppers, a pair of strong hand shears, a pruning saw, and a ladder are needed. A can of water-asphalt emulsion paint for the sealing of large cuts may also be useful to carry. The pruning saw in general use is a pull saw with a folding blade 12 to 18 inches in length with a curved cutting edge. To be satisfactory, the curve of the cutting edge should not be too great, and the form and set of the teeth should readily clear the cut of sawdust.

Hand-pruning has been made easier by the use of air, electric or hydraulic power equipment (fig. 10). Each has its advantage and disadvantage. Air equipment is lighter than electric or hydraulic, but air saws have less torque.

Power tools used in conjunction with mobil platforms to position the pruner in the tree, have increased the speed and efficiency of pruning. Several companies market specialized machines which can be operated by one man. In some cases, growers have built their own pruning platforms, mounted

Fig. 11. Mechanical hedger. (Courtesy Kimball Toppers.)

on a tractor or other vehicle, which can be moved through the orchard.

Hedging machines (fig. 11) consist of a row of power-driven circular saws on a vertical boom which is mounted on a self-propelled or tractor-pulled chassis. Topping machines consist of a horizontal arm of circular saws or, in some cases, a rotating cross arm with independently rotating saws at the end of each arm. The cross arms rotate as the machine moves down the row, and the combined action of the rotating arms, plus the rotating saw blades serve to throw the cut branches out of the top of the tree into the row. For lighter wood, hedging and topping machines are sometimes constructed using a heavy sickle bar mower as the cutting mechanism.

Mechanical hedgers and toppers are usually custom built by commercial operators who contract to hedge and top trees on a per-acre basis.

Brush left in the orchard is usually windrowed and run through a cutter or chopper. The residue is spread over the ground to serve as a moisture-retaining mulch.

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